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A Unifying Approach to Mind and Brain: Ten Year Perspective

R.W. SPERRY

Division of Biology, California Institute of Technology, Pasadena, Calif. 91125 (U.S.A.)

The idea that the course of physiological events in the brain can be influenced by the contents of subjective experience has long been vigorously opposed by nearly all scientists and most 20th century philosophers. A working assumption of neuroscience holds that a complete causal explanation of brain function is possible, in principle, in terms entirely objective and material without any reference to conscious or mental agents. The conceptual brain model based on impulse transmission, membrane potentials, ion transport, transmitter substances, and the like has seemed to have no need nor any place for the action of mental influences or of anything like conscious experience. Theories of consciousness acceptable to science have accordingly conceived the mind-brain relation always in such a way that the neural mechanisms would function the same whether accompanied by consciousness or not (Boring, 1942). Since conscious mental phenomena are thus supposed to make no difference in brain processing, it follows that they can safely be ignored in science, as can also those disciplinary approaches to brain and behavior based in introspection and inner experience.

This traditional stance of behaviorist-materialist science has come into question in recent years, beginning in the mid-1960s when a modified concept of mind was perceived suggesting a way in which conscious experience might exert causal influence in the brain to control behavior on terms acceptable to neuroscience and without violating principles of scientific explanation (Sperry, 1965). In direct contradiction to the founding thesis of Watsonian behaviorism, consciousness in this new framework was interpreted to be an integral part of the brain process and an important directive force in brain function. The contents of consciousness were assumed to play an active control role as causal determinants in brain activity and were recognized to be functional phenomena in their own right "distinct from and more than" the component biophysical and neurochemical processes.

To center in on the concepts involved in these developments we first by-pass previous theories in which consciousness was explained as (a) an epiphenomenon, (b) an inner aspect of cerebral activity, (c) as being identical to the neural events (psychophysical identity theory) or (d) as an artifact of semantics, or pseudoproblem. We focus instead on the interpretation of consciousness as an emergent of brain activity, as argued especially by the

Gestalt school of psychology back in the 1930s and '40s. However, we then discard the Gestalt interpretation of the emergent properties as passive correlates of cortical activity, and also the idea that psychoneural correlations involve isomorphic or topological correspondence between the neural and the perceived mental events. We by-pass also the hypothesis that the events of perception are correlated with electric field forces and volume current conduction patterns in the cortex (Kohler and Held, 1949). We must largely reject as well the extreme Gestalt position with respect to analysis that disclaims the value of explanation in terms of the parts.

Alternatively we interpret the emergent conscious properties in terms of conventional neural circuit theory. A further postulate is added in which the subjective conscious effect of a brain process is viewed as a functional or operational derivative. In other words, subjective meaning is conceived to depend primarily on the way a given cerebral process works in the context of brain dynamics. What counts in determining a conscious perceptual effect is the preparation to respond to a perceived outside stimulus in an adaptive, meaningful adjustment, rather than the way in which the brain's neural process happens to copy or correspond with the perceived stimulus with respect to shape, size, unity, texture, timing, etc. (Sperry, 1952). Conscious phenomena, thus conceived as dynamic emergent properties of high order cerebral processes, are not merely products of neural complexity but are also designed specifically to produce operational subjective effects.

In the cerebral chain of command, the high order subjective properties are seen to supersede the infrastructural details of nerve impulse traffic and physicochemical interactions. The causal potency of consciousness in the brain's control hierarchy is conceived largely in terms of the universal power of a whole over its parts. Conscious cerebral processes, as dynamic entities in brain activity, contain entitive systemic properties that exert controlling influence over many aspects of the component physicochemical elements of which they are built. As with any part-whole relationship, a mutual interaction prevails in which the conscious mental effects are determined by the neural events, including their molecular and atomistic components, while these latter in turn are reciprocally controlled by the higher holistic or systemic properties of the conscious cerebral process in which they are embedded.

The foregoing approach to the mind-brain relation arose largely out of efforts to explain the seeming unity and/or duality of conscious experience in the bisected brain (Sperry, 1970a). Subjective unity, like other aspects of conscious awareness, seemed to be most effectively accounted for as an operational derivative in which the conscious effect was determined by the contextual functional impact of the brain process in question, i.e., the way it worked to influence ongoing brain activity. On these terms each of the surgically disconnected hemispheres could logically have its own separate unified stream of conscious experience. In the normal intact brain, on the other hand, the two hemispheres must typically act as a unit where subjective unity could be inferred to involve a coherent bilateral brain process spanning both hemispheres through the commissures (Sperry, 1970b, 1974, 1976). Underlying assumptions implied (a) that conscious awareness may be sustained by connecting fiber systems of the brain as well as by the switching sites and

transmission interfaces of the gray matter, and (b) that the fiber systems interconnecting the hemispheres are not different in principle, in this respect, from fiber systems within a hemisphere.

Among other advantages this interpretation of subjective unity seemed to resolve the bothersome philosophical problem of "grain," so-called, in which the particulate discontinuousness or "graininess" of neural activity has always seemed difficult to correlate with the smooth, continuous non-grainy content of subjective experience. The mental effect need not correlate with the array of excitatory details comprising the infrastructure of a brain process, but only with the overall operational impact. Finally, an "operational impact" logically implies a causal influence on the part of the conscious properties involved.

Viewed broadly the above scheme provided in theory a neural-based model for phenomenology and for psychophysical interaction. It gave subjective experience a tangible use in a physical world and a reason for having been evolved. In effect it served to restore conscious mind to the brain of experimental science and brought scientific theory at long last into line with common sense impressions on the mind-controlling-behavior issue. More specifically, the scheme brought together and fused into a unifying conceptual framework, divergent theoretical tenets from materialist vs. mentalist, and monist vs. dualist doctrines that formerly were disparate and conflicting. Today these concepts acquire some additional reassurance by having survived wide circulation in the literature for more than ten years with plenty of opportunity for critics to shoot them down. The aim in the present is not to further explicate or reinforce these ideas as such, but, rather, to take the model as it stands, and put it more in perspective, noting some of the broader implications and general consequences.

The emergence during the past decade of a neural-based conceptual model for explaining psychophysical interaction and mental control in brain function and behavior has helped to strengthen a general swing during this period toward mentalism and humanism in behavioral science and philosophy — away from behaviorism, reductionism, and mechanistic determinism. Proponents of cognitive, clinical, humanistic and related disciplines in psychology that prefer to work directly with subjective experience have acquired a new scientific clout in recent years enabling them to stand up to the behaviorists and physical scientists in a way that was not possible before the mid 1960s when psychophysical effects were ruled out on principle and the opposing subjective and objective approaches seemed, at best, to pose a puzzling and irreconcilable paradox (Wann, 1965). Meanwhile in the area of mind-brain relations mentalists, dualists and psychophysical interactionists after having been essentially silent and invisible for decades, have suddenly begun to reappear in considerable numbers proclaiming various anti-materialist, anti-reductionist positions. It has not mattered that no firm proof is yet available; there is none either for the behaviorist-materialist doctrine. Success of the latter has depended largely on the seeming total inconceivability that neural mechanisms could be influenced by subjective experience. Undermining materialist convictions on this point has released the floodgate pressures of subjectivist interests everywhere.

Our model carries no support for the increased intellectual tolerance of

parapsychology and of the mystical and metaphysical generally, that also have ridden the recent rise of interest in mentalism. Chances that mental influences could pass by telepathy from one brain to another or affect any distant object on the above terms, or exist in any way independently of brain activity look, if anything, less hopeful than before. The mental phenomena remain directly tied to the brain as functional properties of cerebral mechanisms in action.

The kind of causal control envisaged represents an intermediate between mechanistic determinism and full volitional freedom pointing to a compromise resolution for the age-old issue of free will vs. determinism. A "self-determining" interpretation for human decision-making is implied (Sperry, 1965, 1976). Our seemingly free decisions are seen to be causally determined, as science would have it, but, as we personally would prefer to believe, these decisions are determined at a subjective mental level largely, rather than at the molecular or neuronal level of causation, by our own mental inclinations. The sequence of events in the brain leading to a particular choice is determined literally, in an objective causal sense, by what we desire and most value. A kind of personal control and self-determination is provided that most of us would prefer over complete freedom. Complete freedom from causation would leave our thought, decisions and behavior subject to random meaningless chance and caprice.

On these terms psychology and psychiatry rate as distinct scientific disciplines in their own right, not reducible to neurophysiology or biology. Causal interactions involved at the conscious mental levels of cerebral function have laws and dynamics that are hardly included in neurophysiology as traditionally conceived. The kind of mental control over physicochemical events that is implied involves no violation of the laws and principles of neurophysiology — any more than the presence of higher controls for the speed and direction of ambulation violates the chemistry and physiology of muscle contraction or nerve impulse conduction. Different levels of organization and causal control are operative. Where the causal sequence of cerebral events includes conscious mental properties, the concepts of physiology need to be supplemented — but not substituted or dispensed with. Phenomena at any one level of brain action are largely (though not entirely) determined by, and explainable in terms of, component events at the next lower level. However, the subevents at successively elementary levels become increasingly irrelevant and incomplete in themselves as an explanation. Search for the chemistry or molecular biology of psychological activities as an ultimate end is misguided conceptually, but such efforts are not without valuable explanatory spin-off at subsystem levels.

The above approach to the mind-brain interface has seemed in a number of respects to have something for everyone. On different occasions I have been informed by proponents of mentalism, behaviorism, phenomenology, reductionism, Gestaltism, humanism, determinism, emergent theory, existentialism, psychophysical identity theory, monism, and even classical dualism, that this interpretation is what is meant by each of these respective positions. Those who lean toward materialism stress that the conscious effects are determined by, and are properties of, and inseparably linked to, the material brain process with all its anatomical and physiological constraints, and that separate

metaphysical or dualistic realms of existence or truth are discounted. Those who lean to dualism and mentalism on the other hand (Eccles, 1970) emphasize that the subjective mental phenomena are realities in their own right to be recognized as distinct entities, different from and more than the component neural events of which they are built and not reducible to these components. They also find attractive the fact that the fate and course of the constituent neural events is subject to control by the supersedent mental properties.

Monists acclaim the idea of a single continuous hierarchy in the brain that extends from the brain's subnuclear particles on up through atoms, molecules, cells, and nerve circuits to include at the uppermost levels the events of conscious experience. Pragmatists are in accord with the operational derivation of conscious meaning. Reductionists point out that the conscious effects are built of neural events, and must therefore be explainable largely in terms of those events. Concepts involving "cell patterns and assemblies", "spatio-temporal patterns", and "frequency encoded configurations" easily take on added psychophysical interactionist connotations in the new perspective. Since the appearance of this unifying approach in 1965, gradual shading of related thinking to include congenial aspects has made it increasingly difficult to differentiate various related philosophical positions and one must go back to the "pre-65" descriptions to see clear distinctions.

On the above terms the whole value-rich world of inner experience, formerly the sole province of the humanities and specifically excluded in principle from materialist science, becomes reinstated in theory as part of the domain of science (Sperry, 1972). Subjective phenomena, including values, gain objective consequences and can be treated scientifically as prime causal determinants in decision making. In short, there is new promise that some of the major long-standing paradoxes like those between mind and brain, objective and subjective, fact and value, free will and determinism and that between *is* and *ought* that have long puzzled and polarized human thinking may one day be resolved in a unifying approach to mind, brain and physical reality.

Looking ahead, the most promising route by which we may hope to eventually obtain definitive answers in the mind-brain area appears to lie in advancement of our neurological analysis of brain processing, particularly at its upper levels, with special attention focused on a search for those critical differences that distinguish the cerebral mechanisms that involve conscious experience from those that do not. What are the very special differences in cerebral processing responsible for subjective experience that distinguish, for example, the mechanisms of simple conscious sensations from various equally and perhaps much more complex but nevertheless unconscious, cerebellar activity? All kinds of brain processing can be said to have an inner as well as an outer objective aspect, and both aspects all through the neural hierarchy can be said to have neural identity. However, it apparently is only certain of these different kinds of neural events that yield subjective conscious experience. On the above terms we are led to look upon the subjective effects as being specific and selective, not universal, features of cerebral function, introduced and developed in brain evolution because they facilitate brain processing and decision making.

Once neuroscience has progressed to the point where we can understand what kinds of organizational variables in the neural mechanisms are required to produce conscious experience, it should then be logically possible to infer the extent to which these and therefore consciousness may be present in various subhuman nervous systems, and also the extent to which it may be possible perhaps to build conscious experience into a computer.

The present scheme leaves the future problem for neuroscience and philosophy of defining in operational terms the essential functional role played by subjective awareness. Precisely what benefits, from a functional, engineering standpoint, are conferred by the introduction in evolution of subjective conscious effects? Thinking on this question has only just begun along lines like the following: consider the tactical difference between responding to the world directly and responding to inner conscious representations, models and signs of the world. Wherever displacement in time or space are advantageous, as in mental recall or anticipation (both of which are critical to the learning process) the use of inner representations becomes a necessity. The real world can hardly be manipulated like inner images. Responses involving perceptual constancies in shape, size, position and the like would seem also to be more effectively managed through inner representations. Further, the use of implicit trial and error responses to inner mental models (thus avoiding overt response commitment with errors in the real world) is a central aspect of the thinking process.

The development of an inner subjective world may be viewed broadly as part of the evolutionary process of freeing behavior from its initial primitive stimulus-bound condition to provide increasing degrees of freedom of choice and originative central processing. The subjective effects may also be seen to have special advantages as general positive and negative reinforcers in learning situations and later for motivation, evolving into ends in themselves in the directive control of much of human behavior. In every case it must be asked why the evolutionary developments could not have occurred, at least as readily and effectively, in the absence of subjective effects.

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REFERENCES

Boring, E.G. (1942) *Sensation and Perception in the History of Experimental Psychology*. Appleton-Century, New York.

Eccles, J.C. (1970) *Facing Reality*. Springer-Verlag, New York.

Kohler, W. and Held, R. (1949) The cortical correlate of pattern vision. *Science*, 110: 414–419.

Sperry, R.W. (1952) Neurology and the mind-brain problem. *Amer. Scientist*, 40: 291–312.

Sperry, R.W. (1965) Mind, brain, and humanist values. In *New Views on the Nature of Man*, J.R. Platt (Ed.), University of Chicago Press, Chicago, Ill., pp. 71–92. Reprinted (1966) in *Bull. Atom Sci.*, 22: 2–6.

Sperry, R.W. (1970a) Perception in the absence of the neocortical commissures. *Ass. Res. nerv. ment. Dis.*, 48: 123–138.

Sperry, R.W. (1970b) An objective approach to subjective experience: further explanation of a hypothesis. *Psychol. Rev.*, 77: 585–590.

Sperry, R.W. (1972) Science and the problem of values. *Perspect. Biol. Med.*, 16: 115–130. Reprinted (1974) in *Zygon*, 9: 7–21.

Sperry, R.W. (1974) Lateral specialization in the surgically separated hemispheres. *The Neurosciences: Third Study Program*, F.O. Schmitt and F.G. Worden (Eds.), MIT Press, Cambridge, Mass.

Sperry, R.W. (1976) Mental phenomena as causal determinants in brain function. *Process Studies*, 5: 247–256.

Wann, T.W. (Ed.) (1965) *Behaviorism and Phenomenology: Contrasting Bases for Modern Psychology*. University of Chicago Press, Chicago, Ill.